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Indian Standard

IS 3315 : 2019

वाष्पीकरणीय हवा कूलर (डेजर्ट कूलर) — विशिष्टि

(तीसरा पुनरीक्षण)

Evaporative Air Coolers (Desert Coolers) — Specification

(Third Revision)

ICS 91.140.30

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Refrigeration and Air Conditioning Sectional Committee, MED 03

FOREWORD

This Indian Standard (Third Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1956 and subsequently revised in 1974 and 1994.

The third revision has been taken up to keep pace with the latest technological developments and international practices. In this revision following major changes have been made:

a) Material specification, and

b) Method of measurement of noise level.

A scheme of labelling environmentally friendly products with ECO logo known as ECO-Mark has been introduced at the instance of Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India. The ECO-Mark would be administered by the Bureau of Indian Standards (BIS) under the *Bureau of Indian Standards Act,* 2016. The Ministry of Environment, Forests and Climate Change, Government of India, issued a notification dated 17 May 1996 [GSR 214(E)] for ECO labelling of evaporative air coolers (desert coolers). These ECO labelling criteria relevant to evaporative air coolers (desert coolers) have been incorporated in this Indian Standard.

This revision incorporates Amendment No. 1 (May 2004) and Amendment No.2 (March 2007).

The composition of the Committee, responsible for the formulation of this standard is given at Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

EVAPORATIVE AIR COOLERS (DESERT COOLERS) — SPECIFICATION

(Third Revision)

1 SCOPE

1.1 This standard covers the air capacity, constructional features, performance requirements and methods of testing for evaporative air coolers suitable for rated voltage up to and including 250 V, 50 Hz. ac.

1.2 These coolers are not suitable if difference between dry bulb temperature (DBT) and wet bulb temperature (WBT) is less than 3°C and humidity is over 75 percent.

2 REFERENCES

The standards listed below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below:

IS No.	*Title*
277 : 2018	Galvanized steel strips and sheets (plain and corrugated) — Specification (*seventh revision*)
302 (Part 1) : 2008	Safety of household and similar electrical appliances: Part 1 General requirements (*sixth revision*)
694 : 2010	Polyvinyl chloride insulated unsheathed and sheathed cables/ cords with rigid and flexible conductor for rated voltages up to and including 450/750 V (*fourth revision*)
996 : 2009	Single-phase a.c. induction motors for general purpose (*third revision*)
1391 (Part 2) : 2018	Room air conditioners — Specification: Part 2 Split air conditioners (*third revision*)
2312 : 1967	Propeller type ac ventilating fans (*first revision*)
3854 : 1997	Switches for domestic and similar purposes — Specification (*second revision*)
9968 (Part 1) : 1988	Elastomer insulated cables: Part 1 For working voltages up to and including 1 100 V (*first revision*)
11951: 2009	Pumpset for desert coolers

3 DEFINITIONS

For the purpose of this standard, the following definitions shall apply.

3.1 Evaporative Air Cooler — A device which cools air by evaporation of water.

3.2 Evaporative Air Cooling — It involves the process of evaporating water into air stream. Air is cooled by direct contact with water through a wetted surface. The heat and mass transfer process between the air and water lowers the air dry bulb temperature at constant wet bulb temperature.

3.3 Temperature (Dry Bulb - DBT) — The temperature of air read on a thermometer placed in such a way as to avoid errors due to radiation.

3.4 Temperature (Wet Bulb - WBT) — The steady temperature finally given by a thermometer having its bulb covered with gauze or muslin moistened with distilled water and placed in air with relative velocity of not less than 2.5 m/s.

3.5 Cooling Efficiency — The extent to which the leaving air dry bulb temperature approaches the wet bulb temperature of entering air is expressed as cooling efficiency. It is expressed as:

$$= ((T_{db} - T_{db'})/(T_{db} - T_{wb})) \times 100$$

Where,

T_{db} = dry bulb temperature of inlet air;

$T_{db'}$ = dry bulb temperature of outlet air; and

T_{wb} = wet bulb temperature of inlet air.

3.6 Zero Static Pressure — It is the pressure at the outlet of air cooler made equal to the static pressure at the inlet of the air cooler.

4 MINIMUM AIR CAPACITY

The minimum air capacities of the evaporative air coolers based on the delivery of air at 'Zero' static pressure shall be as under:

750, 1 000, 1 260, 1 500, 1 800, 2 000, 2 500, 3 000, 4 000, 5 000, 6 000 and 8 000 m^3/h

NOTE — Other capacities may also be supplied as per agreement between the manufacturer and the purchaser.

5 MANUFACTURE AND CONSTRUCTION

5.1 Enclosure

To ensure rigidity and life, the body shall be made out of galvanized steel sheet with grade of coating 275 minimum conforming to IS 277. The sump tank shall be manufactured from a sheet of minimum 1 mm thickness and rest of the cabinet from a sheet of nominal 0.8 mm thickness with the tolerance as given in IS 277.

For plastic body the manufacturer shall declare the properties such as weathering, ageing, colour fastness due to exposure to sun light, resistance to heat flammability, etc. The thickness of body and extent of fire retardant used shall be declared. Body shall be subjected to drop test by dropping the body from a height of 1 m. The body shall be no crack or damage after the drop test.

NOTE — Since sufficient data were not available test requirements of plastics materials are not specified. As soon as details are available same would be considered for inclusion in the specification.

5.1.1 The design and assembly of the equipment shall be such that vibration does not cause rattling and loosening of parts and create excessive noise.

5.1.2 Parts which require service and replacement shall be interchangeable and readily accessible.

5.1.3 The body should be so designed that during normal working water shall not blow off, leak or drip from air cooler.

5.1.4 *Grill*

The front grill shall be made of non-corrosive material with an arrangement for adjusting horizontal and vertical directional flow of air.

5.1.5 *Water Feeding Arrangement*

Suitable water feeding arrangement shall be provided from the back side or from the front side.

5.1.6 *Size of Fan Opening (Not Grill Opening)*

This circular opening shall be more than fan sweep but shall be not exceeding more than 25 mm.

5.2 Filter Pads

Filter pads shall be made of wood wool/honey comb or any other environment friendly material placed in non-corrosive wire mesh or plastic parts and tightened at places with side panels to avoid sagging.

5.3 Sump Tank Capacities

Sump tanks for evaporative air coolers which does not need to be connected to continuous water supply shall have the following minimum capacities according to different nominal capacities of air coolers as given in Table 1.

Table 1 Sump Tank Capacities

(*Clause* 5.3)

Sl No.	Minimum Capacities (m^3/h)	Sump Tank Capacity (litres)
(1)	(2)	(3)
i)	750	15
ii)	1 000	20
iii)	1 200	24
iv)	1 500	30
v)	1 800	36
vi)	2 000	40
vii)	2 500	50
viii)	3 000	60
ix)	4 000	80
x)	5 000	100
xi)	6 000	120
xii)	8 000	160

NOTE — Air coolers having minimum capacities up to 2 000 m^3/h shall be regarded as portable.

5.3.1 Each cooler shall be provided with an accessible drain hole minimum 10 mm diameter. The drain cock and drain cock cap shall be of non-corrosive material.

5.4 Fan

5.4.1. The fan blade shall be well balanced. Fan material can be either of sheet metal or suitable plastic type. The blade and blade carriers shall be securely fixed so that they do not get loose in operation. The metallic parts shall be powder coated or suitably protected against corrosion.

5.4.2 The bearing used shall be such as to ensure quiet running, good service and shall be self-lubricating to reduce lubricating frequency. The provision for lubrication shall be made. The fan shall have resilient mounting so as to reduce noise and vibration.

5.4.3 The fan shall be tested as per IS 2312 except air delivery and power consumption.

5.4.3.1 Fan motor used shall conform to IS 996.

5.5 Pump Set

Pump set used in evaporative air coolers shall conform to IS 11951.

6 PERFORMANCE REQUIREMENTS

6.1 The overall design of the air cooler shall be such that reasonably silent performance is obtained. It is recommended that noise level should not be more than 65 dBA at 1 m distance from the desert cooler when tested in an anechoic room. An alternate method of sound test as per IS 1391 (Part 2) can be used.

6.2 The air cooler shall satisfy the following requirements under the standard rating conditions specified in **10**:

a) The air delivery shall be not less than the declared minimum air capacity;
b) The cooling efficiency shall be not less than 65 percent; and
c) Power consumption — The power consumption at zero static pressure shall not exceed the values given in Table 2.

Table 2 Power Consumption

(*Clause* 6.2)

Sl No.	Minimum Capacities m^3/h	Max Power Consumption(W)
(1)	(2)	(3)
i)	750	95
ii)	1 000	125
iii)	1 200	150
iv)	1 500	185
v)	1 800	210
vi)	2 000	225
vii)	2 500	240
viii)	3 000	250
ix)	4 000	280
x)	5 000	350
xi)	6 000	400
xii)	8 000	500

7 ELECTRICAL EQUIPMENT

7.1 Wiring

Electrical wiring and connection shall conform to the requirements of IS 302 (Part 1). All electrical joints shall be electrically and mechanically secure. Where any cable, passes through metal holes, the metal edges, shall be fitted with a grommet of suitable insulating material, so as to protect the cable from damage and possible earthing.

7.2 The metal casing of the electrical components, metal frame or chassis of cooler cabinet and all exposed metallic parts, likely to become live, shall be provided with earthing facilities in accordance with the requirement given in IS 302 (Part 1). One 'ON' and 'OFF' and one speed regulator switch shall be provided with each evaporative cooler. The switch shall conform with IS 3854. Provision shall be made to run fan and pump set separately or facility to stop water circulation in the unit.

7.3 Suitable power cable conforming to IS 694 or IS 9968 (Part 1) of minimum 2 m length shall be provided with each unit. The length should be measured from the outer body of unit.

8 TEST

8.1 Classification of Tests

Test shall be classified into following two groups:

a) Routine tests, and
b) Type tests.

8.1.1 *Production Routine Tests*

These shall consist of routine tests that would be conducted on every assembled unit by a manufacturer.

8.1.2 *Type Tests*

The type tests shall consist of the tests that would be necessary to check up the performance and characteristics of the units and components. Once a cooler has undergone type tests, any major or minor alterations, which the manufacturer, intends to make, shall be reported to the testing authority and further type tests shall be carried out in accordance with the procedure laid down in this standard (*see* **8.4**).

8.2 Production Routine Tests

8.2.1 *General Running Tests*

The unit shall be given a run to ensure vibration free and through running of all the parts.

8.2.2 *Protection against Electric Shock*

The unit shall be tested for protection against electric shock as per **8** of IS 302 (Part 1).

8.2.3 *High Voltage Tests*

The unit shall be tested for high voltage test as per IS 302 (Part 1).

8.2.4 *Insulation Resistance Test*

The unit shall be tested for insulation resistance test as per **16.3** of IS 302 (Part 1). This test shall be performed after high voltage test.

8.2.5 *Leakage Current*

The unit shall be tested for leakage current as per **13** of IS 302 (Part 1).

8.2.6 *Earthing Connections Tests*

The unit shall be tested for earthing connection as per **27** of IS 302 (Part 1).

8.2.7 *Finish*

All surface assembly of the cooler shall be of corrosion resisting material or shall be suitably and durably protected against corrosion and scratch.

8.2.8 *Power Consumption Test*

The unit shall be tested for power consumption test at free air flow conditions. This power consumption figure would not exceed the value arrived at by subtracting differential 'D' from the maximum permissible power consumption at zero static pressure test conditions as given in **6.2**(c). Differential 'D' would be the difference between the actual power consumption observed at zero static pressure test conditions of an air cooler selected at random from the given lot and the actual power consumption of the same air cooler at free air flow conditions. If more than one air coolers are tested at zero static pressure conditions, then maximum observed differential would be subtracted from maximum permissible wattage at zero static pressure test conditions, for arriving at acceptable value of power input for air coolers at free air flow conditions.

8.3 Rating

8.3.1 *Rating Voltage*

The rated voltage shall be 230 ~ 240 volts.

8.3.2 *Rated Frequency*

The rated frequency of cooler shall be standard frequency of 50 Hz.

8.4 Type Tests

8.4.1 Besides all the production and routine tests outlined in **8.2** the type test shall comprise the following:

a) Verification of marking as specified in **7** of IS 302 (Part 1);
b) Cooling efficiency test as specified in **10.4**;
c) Air delivery test as specified in **10.4**;
d) Power consumption test as specified in **6.2**; and
e) All tests as defined in IS 2312 except air delivery and power consumption tests.

8.4.2 *Cooling Efficiency and Air Delivery Test*

Under stable operating conditions laid down in **10.5**, at least five readings shall be taken at equal intervals of not less than 15 min. The arithmetical averages of these readings shall be adopted as final values to calculate:

a) Cooling efficiency, and
b) Air delivery.

8.4.3 *Power Consumption*

The power consumption shall not exceed the values specified in **6.2** and tested in accordance with **8.2.8** at zero static pressure conditions.

9 ADDITIONAL REQUIREMENTS FOR ECO-MARK

9.1 The evaporative air cooler (desert cooler) shall conform to the requirements for quality, safety and performance prescribed in **5** to **8**.

9.2 The manufacturer shall produce the consent clearance as per the provisions of *Water (Prevention and Control of Pollution) Act,* 1974, *Water (Prevention and Control of Pollution) Cess Act,* 1977 and *Air (Prevention and Control of Pollution) Act,* 1981 along with the authorization, if required under the *Environment (Protection) Act,* 1986 to BIS while applying for ECO-Mark.

9.3 Noise Level

For ECO-Mark the evaporative air cooler shall conform to the noise levels as notified under the *Environment (Protection) Act,* 1986 from time to time.

9.4 Instructions

The evaporative air cooler shall be sold along with instructions for proper use so as to maximize product performance, minimize wastage and method of safe disposal of used product.

9.5 Energy Consumption

The power consumption shall be at least 5 percent less than those specified in **6.2.**

9.6 Packing

The evaporative air cooler shall be packed in such packages, which are made of recyclable or biodegradable materials.

10 GENERAL TEST CONDITIONS

10.1 Unless otherwise specified the tests shall be made on the air cooler installed as for normal use, with the accessories, grills, etc., if any, in their normal position in accordance with the manufacturer's instructions.

10.2 Standard Ratings

10.2.1 Cooling efficiency test may be conducted at any ambient temperature. The relative humidity of inlet air to the air cooler shall be maintained at any value

between 25 percent and 55 percent. During the test relative humidity shall not vary more than ± 5 percent.

10.2.2 Air delivery test may be conducted at any ambient temperature prevailing at the time of test.

10.2.3 The evaporating medium shall be dry during the air flow test.

10.2.4 The appliance shall be complete with all components and accessories necessary for an actual installation in place.

10.2.5 The evaporation medium and components for determining cooling efficiency and air flow test will remain same.

10.3 The static pressure difference between the air delivered by the air cooler at the outlet of the air cooler in the mixing chamber and the ambient conditions of inlet air cooler in the test room shall be adjusted to give zero static pressure with the help of exhaust fan and damper.

10.4 The air cooler shall be operated to give maximum:

(a) cooling efficiency; and

(b) air delivery.

10.5 Stable Operating Conditions

The air cooler shall be operated under conditions specified in **10.1** to **10.4** with air flow and temperature measuring apparatus *(see* **12)** attached to it, for a reasonable time to establish thermal equilibrium. Stable operating condition is deemed to be reached when during an interval of 15 min the temperature measured at the same position does not vary by more than 0.5°C. Stable operating conditions are deemed to maintain when the dry bulb temperature at the outlet of the mixing chamber remains within 1.5°C of the average value adopted as given in **8.5.2.** The test shall be continued until at least five successive readings within the permissible range are obtained.

10.6 The voltage supply and frequency to the air cooler shall be adjusted within ± 2 percent of the motor rated voltage.

11 ACCURACY OF INSTRUMENTS

11.1 The accuracy of the manometers shall be within ± 0.5 mm of water gauge.

11.2 The accuracy of the temperature measuring instruments shall be within ± 0.1°C.

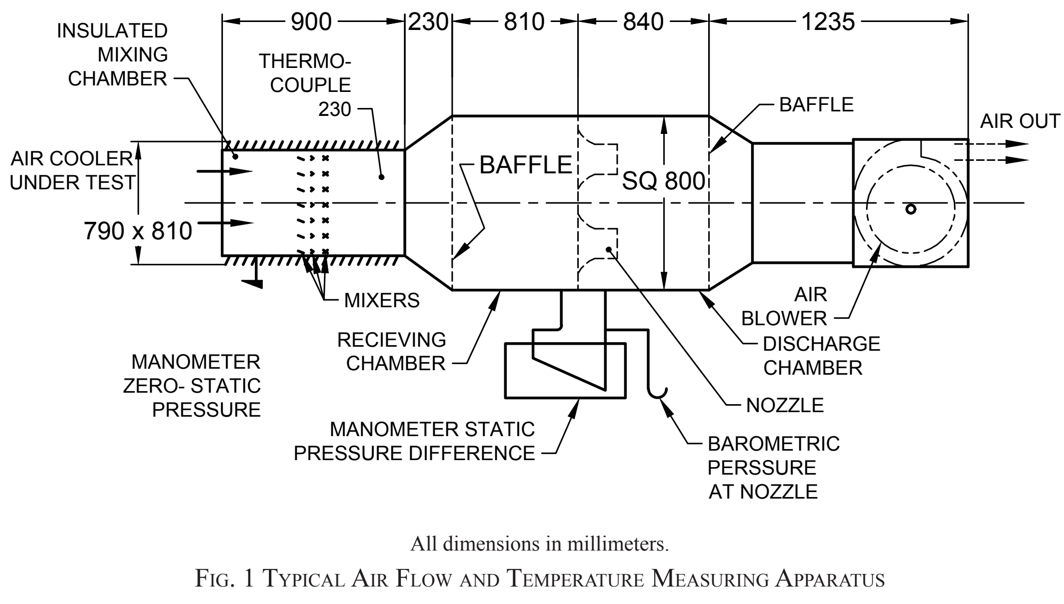
11.3 Electrical measurements shall be made with instruments having accuracy within ± 0.5 percent of the quantity measured.

11.4 The smallest division on the scale of any instrument shall not exceed twice the specified accuracy for it

12 AIR FLOW AND TEMPERATURE MEASURING APPARATUS

12.1 Temperature and flow rate of air delivered by the air cooler are determined as per Fig. 1. The air cooler takes in air at ambient conditions specified in **10.2**. The air leaving cooler first passes through a mixing device to eliminate non-uniformity. The dry bulb temperature shall be measured at the outlet of the mixing device for calculating cooling efficiency of the cooler. Flow rate is determined by measuring the pressure drop across one or more nozzles of the type shown in Fig. 2.

12.2 The inlet air dry bulb temperatures shall be measured at the approximate geometrical centre of the intake surface area of the air cooler at a distance of not less than 25 cm from the cooler. The temperature measurements shall be taken on all sides of the air intake to the air cooler. The air intake surfaces of the air cooler shall not be exposed to radiant heat or direct



All dimensions in millimeters.

FIG. 1 TYPICAL AIR FLOW AND TEMPERATURE MEASURING APPARATUS

air draught. The distance from air intake surface to the next obstruction shall not be less than 1 m. The air cooler shall be placed on a stand at least 50 cm from ground level or on the trolley stand supplied, if any, by the manufacturer.

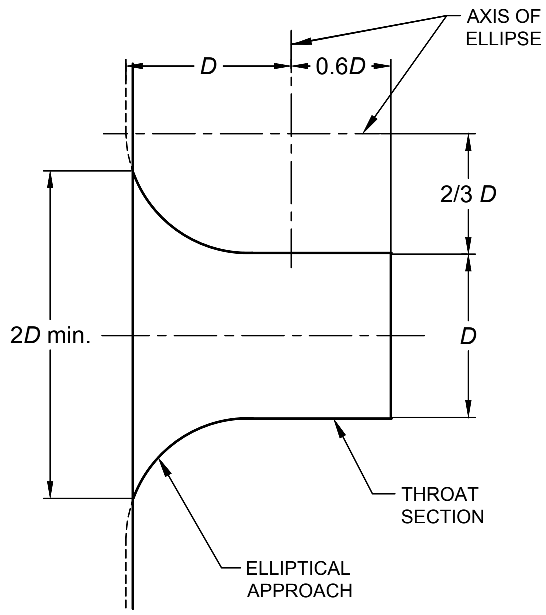


FIG. 2 AIR FLOW MEASUREMENT NOZZLE

12.3 Outlet or outlets of the air cooler shall be connected to a mixing chamber. The mixing chamber shall contain deflectors or vanes to mix air stream. The mixing chamber shall be well insulated so that heat leakage shall be reduced to a minimum. The mixing chamber shall be connected to one wall of the receiving chamber. The temperature measurements are made at the outlet of mixing chambers. The thermometers are so placed so as to ensure the flow of well mixed air over them to measure average temperature. To establish zero static pressure, at the outlet of the air cooler in mixing chamber, with respect to inlet air to the air cooler in the test room, a manometer shall have one side connected to one or more static pressure connections located flush with the inner surface of the mixing chamber. The other side of the manometer is open to inlet air ambient conditions. The static pressure connections shall be located so as not to be affected by air flow.

12.4 One or more nozzles shall be fitted into the wall at the outlet side of receiving chamber, discharging air into discharge chamber. The size and arrangement of the receiving chamber shall be sufficient to provide uniform approach velocity to the nozzle(s). To accomplish this purpose, suitable diffusion baffles may be installed in the receiving chamber, at a distance of not less than 1.5 throat diameter of nozzle from the nozzle inlet.

12.5 Nozzles shall be constructed in accordance with Fig. 2 and fitted into the wall separating receiving chamber from discharge chamber. The throat diameter of the nozzle(s) shall be such that the throat velocity is between 5 m/s and 35 m/s and the total nozzle area is less than 10 percent of the approach duct area. The distance from the centre of any nozzle to any of the four adjacent side walls, either in receiving chamber or in discharge chamber, shall be not less than 1.5 throat diameter of nozzles. The centre to centre distances between the nozzles shall be not less than three throat diameters. If nozzles of different diameters are in use, the distance between axes shall be based upon the average diameter. The dry bulb temperature and wet bulb temperature shall be measured at each nozzle separately. These temperature readings shall be used only for determining the density and specific volume of the air.

12.5.1 The nozzle coefficient of discharge may be determined with the help of Table 3 and 4 or, preferably, the nozzle(s) may be calibrated.

Table 3 Flow Coefficients for Nozzles (C_d)

(*Clause* 12.5.1)

Sl No.	Reynolds Number *Re*	Discharge Coefficient C_d
(1)	(2)	(3)
i)	40 000	0.973
ii)	50 000	0.977
iii)	60 000	0.979
iv)	70 000	0.981
v)	80 000	0.983
vi)	100 000	0.985
vii)	150 000	0.988
viii)	200 000	0.991
ix)	250 000	0.993
x)	300 000	0.994

Table 4 Factor (*f*) to Determine the Reynolds Number

(*Clause* 12.5.1)

Sl No.	Temperature (°C)	Factor, *f*
(1)	(2)	(3)
i)	10	19.4
ii)	15	18.7
iii)	20	18.1
iv)	25	17.5
v)	30	16.9
vi)	35	16.4
vii)	40	15.9
viii)	45	15.5
ix)	50	15.2

Reynolds number R_e for air may be determined from empirical equation:

$$R_e = f.V.D$$

where

f = a factor depending on temperature as given, in Table 4;

V = velocity of air through nozzle in m/h declared nominal capacity divided by total area of nozzles in m^2; and

D = throat diameter of nozzle, in m.

12.6 The air is discharge through nozzle(s) into the discharge chamber. The distance from nozzle to next obstruction in the discharge chamber shall not be less than five throat diameters unless suitable diffusion baffles are used. The distance from nozzle outlet to diffusion baffles in discharge chamber shall be not less than 2.6 throat diameters. If desired, the discharge chamber may be provided with an access door.

12.7 Diffusion baffles, used both in receiving chamber and discharge chamber shall have staggered pattern holes of diameter not more than 6 mm and free area between '45 percent to 55 percent' of the duct area.

12.8 To measure the pressure drop across the nozzle(s) one or more manometers in parallel shall have one side connected to one or more static pressure connections located flush with the inner surface of the receiving chamber. The other side of the manometer(s) shall be connected in a similar manner to one or more static pressure connections in the wall of the discharge chamber. Static pressure connections shall be located so as not to be affected by air flow.

12.9 An exhaust fan/blower with speed regulator shall be connected to the discharge chamber with adjustable damper, to overcome the resistance of chambers, nozzle(s) and diffusion baffles. It shall be able to provide a zero static pressure at the outlet of the air cooler under test.

12.10 The temperature and air flow measuring apparatus shall be sealed reasonably air-tight to ensure that the air delivered by the air cooler is discharged into discharge chamber through nozzle(s) without leakage as far as possible.

13 CALCULATION OF AIR FLOW

13.1 Air volume flow rate through a single nozzle shall be determined as follows: P_o

$$Q = K.\ C_d.\ A.\ \sqrt{\frac{p.v}{1+w}}\ \left\{\frac{Po}{P}\right\}$$

Where,

Q = Volume flow of air, in m^3/h;

K = 1.6×10^4 (a constant);

C_d = Nozzle coefficient;

A = Nozzle(s) area, in m^2;

p = Static pressure difference across the nozzle(s), in mm of water (velocity pressure in mm of water if pitot tube is used);

v = Specific volume of air and water vapour mixture, in m^3/kg of dry air;

w = Specific humidity, in kg/kg of dry air;

P_o = Standard barometric pressure — 760 mm of mercury; and

P = Barometric pressure at nozzle, in mm of mercury.

13.2 Where the barometric pressure *(P)* deviates from the standard barometric pressure by not more than 25 mm of mercury, the factor P_o/P may be considered equal to 1.0.

13.3 When more than one nozzle is in use, the total volume flow rate will be the sum of the volume flow rate *(Q)* of each nozzle calculated as directed in **13.1.**

13.4 An example for calculating air delivery of a cooler is given in Annex A for guidance.

14 GUARANTEE

The cooler shall be guaranteed free from defects in material and workmanship for one year from the date of purchase.

15 MARKING AND INFORMATION

15.1 Each unit shall have the following information on the name plate in a permanent and legible manner in a location where it is accessible and visible.

a) Name of the manufacturer;
b) Type or model number, serial number and year of manufacturing;
c) Minimum air capacity at zero static pressure;
d) Normal total current and voltage;
e) Power input;
f) Sump tank capacity; and
g) Cooling efficiency of the unit.

15.2 The manufacturer shall provide a manual containing necessary information for proper installation, operation and maintenance of the evaporative air cooler. In this manual suitability of coolers of different capacities for different sizes of rooms shall be indicated for the guidance of the users.

15.3 BIS Certification Marking

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark**.**

ANNEX A

(*Clause* 13.4)

EXAMPLE FOR METHOD OF CALCULATION

An example for method of calculation for air delivery of an air cooler has been illustrated for clear understanding. Suppose during a test on an air cooler, following readings were recorded.

Condition of the supply of air to the air cooler:

T_{db} = 39.8°C

T_{wb} = 25°C

Condition of the outlet air from the air cooler:

$T_{db'}$ = 29°C

T_{wb} = 25°C

Differential pressure across nozzles = 10 mm water column

Number of nozzle = 5

Diameter of each nozzle = 0.132 m

Area of each nozzles = 0.013 685 m^2

Total area of 5 nozzles = 0.068 5 m^2

The declared capacity of the air cooler = 3 000m^3/h.

From psychrometric tables,

at $T_{db'}$ = 29°C and

T_{wb} = 25°C

Specific volume of dry air at 29°C (v_a) = 0.855 7 m^3/kg

Specific volume of air mixture per kg of dry air at 29°C (v_s*) = 0.890 8 m^3/kg

Specific humidity of air per kg of dry air at 25°C (w_s*) = 0.020 09 kg/kg

Specific humidity of air per kg of dry air at 29°C (w_s) = 0.025 65

The humidity ratio,

$$w = \frac{(597.30 - 0.56T_{wb})\ w_s{*}. - 0.24(T_{db'} - T_{wb})}{597.30 + 0.44T_{db'} - T_{wb}}$$

$$= \frac{(597.30 - 0.56\times 25)\ 0.020\,09 - 0.24\,(29 - 25)}{597.30 + (0.44\times 29) - 25}$$

$$= \frac{(597.30 - 14)\ 0.002\,09 - \ (0.24\times 4)}{597.30 + 12.76 - 25}$$

$$= \frac{11.718 - 0.96}{585.06}$$

$$= \frac{10.758\,497}{585.06}$$

= 0.018 4 kg/kg of dry air

The saturation ratio

$$\mu = \frac{w}{w_s} = \frac{0.018\ 4}{0.025\ 65}$$

= 0.717 348 9

= 0.717 35

Specific volume of air and water vapour mixture in m^3/kg of dry air,

$v = v_a + \mu\ (v_s{*} - v_a)$

= 0.855 7 + 0.717 35 (0.890 8 - 0.855 7)

= 0.855 7+ 0.717 35(0.035 1)

= 0.855 7 + 0.025 18

= 0.880 88 m^3/kg of dry air

Reynolds number R_e for air may be determined from equation:

$R_e = f.V.D$

Where,

f = a factor depending on temperature as given in Table 4.

V = velocity of air through nozzle in m/h

D = throat diameter of nozzle in m

At $T_{db'}$ =29°C (from Table 4)

f = 17

$$R_e = 17 \times = \frac{3\ 000}{0.068\ 5} \times 0.132$$

R_e = 98 277.372

From Table 3 for R_e = 98 277.372,

C_d = 0.985

Air flow,

$$Q = K.\ C_d.\ A.\ \sqrt{\frac{p.v}{1+w}}\ \left\{ \frac{Po}{P} \right\}$$

$$= 1.6\times 10^4 \times 0.985 \times 0.068\,5 \times \sqrt{\frac{10\times 0.880\,88}{1 + 0.0184\,4}\times 1}$$

$$= 1\,079.56 \times \sqrt{8.649\ 646\ 5}$$

= 1 079.56 × 2.941 03

= 3 175 m^3/h

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, MED 03

Organization	*Representative(s)*
Indian Institute of Technology, Roorkee	Prof (Dr) Ravi Kumar (***Chairman***)
Annapurna Electronics and Services Ltd, Hyderabad	Shri G. K. Prasad Shri J. S. Sastry (*Alternate*)
Bureau of Energy Efficiency, New Delhi	Shri Sameer Pandita Shri Kamal Shaikh (*Alternate*)
Blue Star Ltd., Mumbai	Shri Jitendra Bhambure Shri Sunil Jain (*Alternate*)
Carrier Aircon Ltd, Gurgaon	Shri Bimal Tandon Shri D. Bhattacharya (*Alternate*)
Central Power Research Institute, Bangalore	Shri A. R. Ravi Kumar Shri Gujjala B.balaraja (*Alternate*)
Centre for Science and Environment, New Delhi	Shri Chandra Bhushan
Consumer Education and Research Centre, Ahmedabad	Ms Sweta Mahajan
Danfoss Industries Pvt Ltd, Gurgaon	Shri Madhur Sehgal Shri K. L. Nagahari (*Alternate*)
Electrical Research and Development Association, Vadodara	Shri Gautam Brahmbhatt Shri Rakesh Patel (*Alternate*)
Emerson Climate Technologies(India) Pvt. Ltd, Karad	Shri Chethan Tholpady Shri D. P. despande (*Alternate*)
Godrej & Boyce Mfg. Co. Ltd., Mumbai	Shri Burzin J. Wadia Shri Abhijit A. Acharekar (*Alternate*)
Honeywell International India Pvt Ltd, Gurgaon	Shri Sudhir Kavalath Dr Nitin Karwa (*Alternate*)
Indian Institute of Chemical Engg, Kolkata	Dr D. Sathiyamoorthy Dr Sudip K Das (*Alternate*)
Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), New Delhi	Dr Jyotirmay Mathur Shri Ashish Rakheja (*Alternate*)
Ingersoll Rand, Bangalore	Shri Mittakola Venkanna Shri Jeyaprakash Gurusamy (*Alternate*)
International Copper Association India, Mumbai	Shri Sanjeev Ranjan Shri Shankar Sapaliga (*Alternate*)
Intertek India Pvt Ltd, New Delhi	Shri Balvinder Arora Shri C. M. Pathak (*Alternate*)
LG Electronics India Pvt Ltd, New Delhi	Shri Gaurav Kochhar Shri S. T. Haque Faridi (*Alternate*)
National Thermal Power Corporation, Noida	Shri D. K. Suryanarayan Shri S. K. Jha (*Alternate*)
Refrigeration & Airconditioning Mfr Association, New Delhi	Shri Gurmeet Singh SHri R. K. Mehta (*Alternate*)
Samsung India Electronics Pvt Ltd, Noida	Shri Gaurav Choudhary SHri Kalicharan Sahu (*Alternate*)

Organization	*Representative(s)*
Spirotech Heat Exchanger Pvt Ltd, Bhiwadi	SHRI SUNIL BHARDWAJ SHRI DWIJESH GAUTAM (*Alternate*)
SRF Ltd	SHRI RABINDEER N. KAUL
The Chemours India Pvt Ltd, Gurgaon	SHRI VIKAS MEHTA SHRI NISHIT SHAH (*Alternate*)
The Energy and Resources Institute, New Delhi	SHRI P. S. CHIDAMBARAM SHRI GIRISH SETHI (*Alternate*)
UL India Pvt Ltd, Bengaluru	SHRI V. MANJUNATH SHRI SATISH KUMAR (*Alternate*)
Voltas Ltd, Mumbai	SHRI RITESH SINGH SHRI A. D. KUMBHAR (*Alternate*)
Voluntary Organizationn in Interest of Consumer Voice, New Delhi	SHRI H. WADHWA SHRI B. K. MUKHOPADHYAY (*Alternate*)
In personal capacity *(H.No. 03, Savita Vihar, Delhi)*	SHRI J. K. AGRAWAL
In personal capacity *(506/2, Kirti Apartments, Mayur Vihar, Phase -1 Extension, Delhi)*	SHRI P. K. MUKHERJEE
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Member Secretary

MS. KHUSHBU JYOTSNA KINDO
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